ADVISORY COMMITTEE ON ADVANCED TELEVISION
PLANNING SUBCOMMITTEE
WORKING PARTY 4

INTERIM REPORT
EXECUTIVE SUMMARY

The objective of Planning Subcommittee Working Party 4 is to study and make recommendations regarding the relationship of terrestrial advanced television systems to alternative media, applications and standards. It is also the objective to investigate approaches for growth paths to the future while, at the same time, support timely decisions on an advanced television (ATV) broadcast system with increased performance quality for the end user. Participants of Working Party 4 have addressed issues related to Definitions, Architecture, Alternative Media/Applications, Value (of interoperability), Measures and Metrics. Representatives of the broadcast television, cable television, program production, motion picture, consumer electronics, computer, telecommunications and imaging industries are active in this working party.

Historically, television has been implemented in a particular paradigm; analog, radio frequency modulated transmission, synchronous from studio to end-user display. Technological advances and the need to protect future opportunities makes it possible and necessary that a new paradigm be considered. The compelling force here is to recognize the growing list of alternatives in all steps of the television chain (production, transmission, presentation).

Characteristics such as *interoperability*, *extensibility*, *scalability* and more generally "openness" are ascribed to devices, appliances, applications, systems that can effectively "cope" with an array of alternatives. For the end user, devices/systems with these characteristics allow operations over an array of alternatives in such a way that the impairments are invisible to the user. At the same time, technological advances can be accommodated.

Our imaging world has become more complex and richer in alternatives (media, transmission/distribution, presentations) for a specification conceptually similar to the NTSC specification to be sufficient. New definitions are needed to manage this complexity. Working Party 4 developed concise definitions of the key terms interoperability, extensibility, scalability and in the current context of advanced television systems. These definitions can help to differentiate between otherwise equal candidates. They should also form the basis for defining enabling system concepts.

The majority of the current ATV systems under investigation in the FCC Evaluation Program are fully digital implementations. This permits enhanced functionality of the production, transmission, and display elements in the video chain, thus admitting a new paradigm. Digital transmission and processing, in this way, becomes an important enabling concept for an advanced television system exhibiting interoperability, extensibility and scalability. But it is not alone sufficient. In the next generation video environment, video signals will be represented with IMAGE DATA. IMAGE DATA is defined as the digital equivalent of the video information including image, sound and auxiliary data components. In the future, multiple digital video signal standards will exist for a variety of applications and these signals will be carried over alternative delivery media. For the structured labeling of image data, some form of identification of its components is critical. Working Party 4 preliminary investigations show that the FCC should recognize the mandatory importance of HEADERS and DESCRIPTORS as an enabling method of identifying fully the image data.

These considerations argue for the following:

- - - Adopt an all-digital approach to advanced television systems (contingent on the outcome of the current FCC testing program).
- - - Establish a "new paradigm" wherein the production, transmission and presentation/display elements of the television chain can reflect enhanced functionality largely made possible by the all-digital representation of image data.
- - - Adopt the vital concept of HEADERS and DESCRIPTORS.

Working Party 4 believes that a sound starting point for advanced television as well as a future migration path can be established without delaying the current FCC decision process. However, certain actions should be taken to achieve these objectives:

1. Identify the outcome of the current FCC ATV process as ATV-0, a base-level system:

    a. Maximize utilization of digital video techniques and image data representation.
    b. Apply HEADERS and DESCRIPTORS (as agreed by industry standards groups) as a method of identifying image data.

2. During the forthcoming year, Working Party 4 will:

   a. Coordinate work on HEADERS and DESCRIPTORS including SMPTE and other related industry efforts.
   b. Initiate a case-by-case analysis of each of the proponent system's suitability for cost-effective, optimum quality interoperation with alternative delivery media and applications, including analysis of economic and social impacts.
   c. Define and establish authority for a hierarchical family of IMAGE DATA service levels. Relate this hierarchical family to existing telecommunications network bit rate hierarchies.
   d. Encourage the migration of over-the-air broadcast television (NTSC) towards a hierarchical image data delivery standard as the best compatible and competitive alternative to wired distribution of digital video broadcast service.
   e. Provide input for the full definition of ATV-0 as the base standard.
   f. Support continued investigation of the EIA multiport receiver/terminal concept, including definition of a standardized interface connector in both the analog and digital domains.
   g. Investigate the impacts of signal conversion and transcoding between various television signals in both the hybrid and fully digital television environments.
   h. Evaluate benefits of asymmetric versus symmetric coding based upon spectrum and channel efficiency, interoperability and extensibility.
   i. Investigate the impact of broadband wired network technologies as alternative delivery media.

ADVISORY COMMITTEE ON ADVANCED TELEVISION
PLANNING SUBCOMMITTEE
WORKING PARTY 4

INTERIM REPORT

DECEMBER 31, 1991

ACATS Planning Subcommittee Working Party 4 (Working Party 4) is studying and making recommendations regarding the relationship of terrestrial advanced television systems to alternative media, applications and standards. Since September, Working Party 4 has met monthly to study in a concentrated way the convergence of imaging, communications and computing technologies, particularly in the context of the current FCC decision process on ATV. Participants of Working Party 4 have addressed issues related to on Definitions, Architecture, Alternative Media/Applications, Value (of interoperability), Measures and Metrics. Representatives of the broadcast television, cable television, program production, motion picture, consumer electronics, computer, telecommunications and imaging industries are active in the efforts of Working Party 4.

Objective of Working Party 4 is to investigate and encourage growth paths to the future while, at the same time, supporting timely decisions on an advanced television broadcast system with increased performance quality for the end user. There has been agreement on the following underlining points:

- Imaging is of fundamental importance and value on the human scene--- as technology advances enabling new and better imaging methods, they should be embraced and employed in the marketplace.

- Technology has rapidly advanced to the point that the next major evolution of television can provide enhanced viewing experience for the user, including improved image and audio quality, and at the same time broadened performance and benefits beyond classical broadcast television service.

- It is critical that the decision not foreclose the future in an era of almost certain rapid technological advance which will enable multiple, and cross-industry applications in addition to broadcast television.

- There is need to agree on fundamental concepts, parameters, etc., and soon, so that the technological potential of advanced television systems can be realized in the marketplace for the benefit of end users as well as related product/services suppliers.

The general television system model is accepted as containing production,

transmission (including contribution and distribution) and presentation (display). This model also applies in all cases where image/audio information is delivered at a distance. Historically, television has been implemented in a particular paradigm; analog, radio frequency modulated transmission, synchronous from studio to end-user display. Technological advances and the need to protect future opportunities makes it possible and necessary that a new paradigm be considered. The compelling force here is to recognize the growing list of alternatives in all steps of the television chain (production, transmission, presentation). A limited listing of these alternatives is summarized in Table 1. That this list will continue to grow is a certainty; we need only examine our own homes and offices to find evidence (e.g. video interactive games programed by CDROM, played over telephone lines on TV terminals, video conferencing, interactive video reference libraries, multi-channel entertainment/educational television, desktop multimedia publishing, . . .).

Characteristics such as interoperability, extensibility, scalability and more generally "openness" are ascribed to devices, appliances, applications, systems that can effectively "cope" with an array of alternatives. For the user, devices/systems with these characteristics allow operations over an array of alternatives in such a way that the impairments are invisible to the user. At the same time, technological advances can be accommodated. Over time, the level of specification required to achieve these characteristics has changed along with the increasing complexity of our technology and systems. Physical specifications (image frame and drive sprocket hole locations) allowed long and continuous advances in photographic imaging with a high degree of interoperability and extensibility in related camera, processing, projection devices and systems.

Our imaging world has become more complex and richer in alternatives (media, transmission/distribution, presentations) for a specification conceptually similar to the NTSC specification to be sufficient. New definitions are needed to manage this complexity. Table 2 summarizes concise definitions of the key terms interoperability, extensibility, scalability and in the current context of advanced television systems. These definitions can help to differentiate between otherwise equal candidates. They should also form the basis for defining enabling system concepts.

Across a broad front there is a major evolution from analog to digital delivery implementations; in data systems, in local and inter-exchange carrier telecommunications systems, in advanced imaging systems, in computational systems and anticipated in cable television distribution networks, etc. Majority of the current ATV systems under investigation in the FCC Evaluation Program are fully digital implementations. The testing program under way will determine the performance/quality adequacy of these digital systems that promise higher image/audio quality while consuming no more than RF channel spectrum than current NTSC television. Of greater significance, however, is that all of these candidates require digital image processing and data storage. This permits enhanced functionality of the production, transmission, display elements in the video chain, thus

admitting a new paradigm. Digital transmission and processing, in this way becomes an important enabling concept for an advanced television system exhibiting interoperability, extensibility, scalability by the definitions in Table 2. But it is not alone sufficient.

In the next generation video environment, video signals will be represented with ADVANCED VIDEO AND IMAGE DATA. This data stream is defined as the digital equivalent of video information including image, sound and auxiliary data components. In the future, multiple digital video signal standards will exist for a variety of applications and these signals will be carried over alternative delivery media.

For the structured labeling of image data, some form of identification of its components is critical. Working Party 4 preliminary investigations show that the FCC should recognize the mandatory importance of HEADERS and DESCRIPTORS as an enabling method of fully identifying image data. HEADERS are to identify the types and formats of image data (e.g. still image, motion video, audio and the nature of auxiliary information). HEADERS also identify the type of signal processing performed on the original image data (e.g., image compression, video format conversion, video transcoding, audio compression, type of conditional access technique if any, etc.). DESCRIPTORS identify in detail the types of technical characteristics, parameters essential to be defined for the exact description of the original signal and any signal processing done historically since the signal origination. Incorporation of HEADERS and DESCRIPTORS are critical to preserv future options. The concept could also support more efficient use of spectrum or higher image quality (e.g. source adaptive coding). HEADERS and DESCRIPTORS are being studied by the the SMPTE and considered for standardization in the near future.

These considerations argue for the following:

--- Adopt an all-digital approach to advanced television systems (contingent on the outcome of the current FCC testing program).
--- Establish a "new paradigm" wherein the production, transmission and presentation/display elements of the television chain can reflect enhanced functionality largely made possible by the all-digital representation of image data.
--- Adopt the vital concept of HEADERS/DESCRIPTORS for full image data stream identification and longer term flexibility to accommodate not only existing but also future applications as advances of technology allows those to emerge. HEADERS and DESCRIPTORS are also critical to achieve interoperabilit and can provide extensibility.

CONCLUSIONS

The working party believes that a sound starting point for advanced television as well as a future migration path can be established without delaying the current FCC

decision process. However, certain actions should be taken to achieve these objectives.

1. Identify the outcome of the current FCC ATV process as ATV-0, a base-level system:

    a. Maximize utilization of digital video techniques and image data representation
    b. Apply HEADERS/DESCRIPTORS (as agreed by industry standards groups) as a method of identifying image data.

2. During the forthcoming year Working Party 4 will:

    a. Coordinate work on HEADERS/DESCRIPTORS including SMPTE and other related industry efforts.
    b. Initiate a case-by-case analysis of each of the proponent system's suitability for cost-effective, optimum quality interoperation with alternative delivery media and applications, including analysis of economic and social impacts.
    c. Define and establish authority for a hierarchical family of IMAGE DATA service levels. Relate this hierarchical family to existing telecommunications network bit rate hierarchies.
    d. Encourage the migration of over-the-air broadcast television standard (NTSC) towards a hierarchical image data delivery standard as the best compatible and competitive alternative to wired distribution of digital video broadcast service.
    e. Provide input for the full definition of ATV-0 as the base-level standard.
    f. Support continued investigation of the EIA multiport receiver/terminal concept including definition of a standardized interface connector in both the analog and digital domains.
    g. Investigate the impacts of signal conversion and /transcoding between various television signals in both the hybrid and fully digital television environments.
    h. Evaluate benefits of asymmetric versus symmetric coding based on spectrum and channel efficiency, interoperability and extensibility.
    i. Investigate the impact of broadband wired network technologies as alternative delivery media.

Remainder of this report consists of reports and papers developed in the WP/4 Specialist Groups as well as from companies and individuals that support the conclusions and recommendations set forward above.

ARCHIVE	PRODUCTION	TRANSMISSION/DISTRIBUTION	PRESENTATION/DISPLAY
MEDIA TYPE			
film (16mm, 35mm,...)	film	physical distribution	broadcast TV receivers
video tape (NTSC, PAL, SECAM, HDTV, ...)	video tape	terrestrial	cable optimized "terminals"
optical disk (laser disk, CDROM)	live camera	cable	video capable computers
computer (digital) data (mag disk, opt. disk, ...)	computer generation	satellite	component systems (receiver, processor, display)
		non-switched network	
		switched network	
FUNCTIONALITY			
storage	capture	broadcast	viewing
retrieval	manipulate	point-to-multipoint	manipulation
	telecine conversion	point-to-point	interaction
	transcoding	unidirectional	
	storage	bidirectional	
	motion/still images	data compression	
	graphics, text, audio	encryption	

TABLE 1

DEFINITIONS

Interoperability

The capability of providing useful and cost-effective interchange of electronic image, audio and associated data: among different signal formats, among different transmission media, among different applications, among different industries, among different performance levels.

Extensibility

A property of a system, format or standard that allows changes in performance or format within a common framework, while retaining partial or complete compatibility among systems that belong to the common framework.

Harmonization

The coordination of different advanced image standards in an orderly process.

Scalability

The degree video and image formats can be combined in systematic proportions for distribution over communications channels for varying capacities

Advanced Video and Imaging Data

Digital information representing images and video processed by leading-edge (1991) digital circuitry and algorithms.

Scope of Services and Features

The range of services and features supportable by the control functions and channel capacity devoted to ancillary data in an advanced TV system.

Header/Descriptor

Headers (preceding a digital datastream) provide packetized identifiers of encoding standard, image block length, optional error protection and block synchronization; descriptors add time, data, various ID.

TABLE 2

ADVISORY COMMITTEE ON ADVANCED TELEVISION
PLANNING SUBCOMMITTEE
WORKING PARTY 4

INTERIM REPORT
ATTACHMENTS

The following attachments form the record of Working Party 4's efforts in 1991. Attachment A contains a report on definitions including the most important terms, a glossary of other terms and examples of the most important terms. Attachment B contains diagrammatic reference models for interoperability. Attachment C contains a letter from SMPTE to the FCC regarding the status of their headers / descriptors work. Working Party 4 believes this to be an important example of headers / descriptors which, together with other efforts, will be followed closely over the next year. Attachment D contains the minutes of the three Working Party 4 meetings in 1991.

Attachment A: Definitions.

DRAFT Report on Interoperability Definitions for ACATS-PS-WP4

I. Purpose of Document

The purpose of this document is to set a framework for definitions of terms that are important for the discussions of "interoperability" as it affects advanced television systems and advanced image systems.

The intention is to provide paragraph-size definitions of a few important terms, along with some examples.

A short form of the definition is needed also (e.g., suitable for a New York Times science-type article).

Examples in text form should provide easily understandable and realistic scenarios that both broadcast TV people and computer people can relate to.

Diagrams should be used to illustrate the flow of logic, to illustrate the scope of definitions, etc.

For a larger number of less-significant terms, short definitions will be organized in the form of a glossary.

A. Initial list of terms

The most important terms are:

1. Interoperability
2. Extensibility
3. Harmonization
4. Scalability
5. Advanced video and image data
6. Scope of services and features
7. Headers/Descriptors

performance levels.

The usefulness of the term relates to the idea of achieving a kind of universality of images, in which consumers can obtain image information of any kind, in a form chosen by the consumer to match the consumer's needs, instantly available (or at least in a timely fashion), with an affordable cost.

Examples include film to HDTV to NTSC to ultra-high definition images, for different *formats*. Terrestrial broadcast, satellite, fiber optic networks and coaxial cable represent different *media* that will need to interconnect. Education to medical imaging to entertainment television is an example of different *industries* that can usefully exchange image information. CAD-CAM, image databases, computer art, and entertainment TV are different *applications* of image technology with a need to interoperate. Education, history, entertainment can benefit from interoperation among different *epochs*, using archived as well as current images. Transfer of image data between the U.S., Japan, Europe, South America, Africa and the rest of the world is the *geopolitical* dimension to openness and interoperability.

Measures of interoperability could include ease of processing for conversions, delay associated with such processing, and picture impairments introduced by such processing.

Fig. 1 shows a few examples of interoperability.

The definition given above is consistent with, but more general than a definition of "Interoperability with Alternate Media" agreed to by the T3/S2 Specialist Group on Interoperability and Consumer Product Interface of the Advanced Television Systems Committee on August 12, 1991. That definition focused on interoperability of consumer television devices and interoperability among delivery media, as follows:

a. Interoperability of Consumer Television Devices: As applied to consumer television devices, including receivers, monitors, VCRs, etc., interoperability means the device can process and/or display television signals from a multiplicity of delivery media.

b. Interoperability Among Delivery Media: As applied to program interchange among various delivery media, interoperability means that video and audio program signals intended for delivery by a given medium can be easily transcoded for delivery by other media without loss in video or audio quality other than that imposed by the medium to which the signals are transcoded.

B. Extensibility

The concept of extensibility relates to the ability of systems to evolve over time in a way that retains some measure of interoperability.

Extensibility: A property of a system, format or standards that allows future improvements in performance or format within a common framework, while retaining partial or complete compatibility among systems that belong to the

performance levels.

The usefulness of the term relates to the idea of achieving a kind of universality of images, in which consumers can obtain image information of any kind, in a form chosen by the consumer to match the consumer's needs, instantly available (or at least in a timely fashion), with an affordable cost.

Examples include film to HDTV to NTSC to ultra-high definition images, for different *formats*. Terrestrial broadcast, satellite, fiber optic networks and coaxial cable represent different *media* that will need to interconnect. Education to medical imaging to entertainment television is an example of different *industries* that can usefully exchange image information. CAD-CAM, image databases, computer art, and entertainment TV are different *applications* of image technology with a need to interoperate. Education, history, entertainment can benefit from interoperation among different *epochs*, using archived as well as current images. Transfer of image data between the U.S., Japan, Europe, South America, Africa and the rest of the world is the *geopolitical* dimension to openness and interoperability.

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B. Extensibility

The concept of extensibility relates to the ability of systems to evolve over time in a way that retains some measure of interoperability.

Extensibility: A property of a system, format or standards that allows future improvements in performance or format within a common framework, while retaining partial or complete compatibility among systems that belong to the

An advantage of scalability is that less expensive terminal equipment may be needed to decode only a portion of the data (although for consumer applications, the cost will probably be dominated by the display devices, and it may be more likely to have common receiver processing). Another advantage could be in requiring less channel capacity, so that an otherwise full-service receiver could receive lesser-quality images to save transport costs.

E. Advanced Video and Image Data

The "advanced" refers mainly to the underlying technology than to, for example, the resolution of the images. For instance, an image system that employs sophisticated algorithms and VLSI ASICs to process relatively low-quality images for surveillance produces Advanced Video and Image Data.

Advanced Video and Image Data: Digital information representing images and video processed by leading-edge (1991) digital circuitry and algorithms.

For the Advisory Committee, Advanced Television refers to Enhanced TV and HDTV. The quality of HDTV has been defined for SS-WP-4 according to a CCIR proposal in terms of current television: resolution about twice that of NTSC in both vertical and horizontal directions; temporal resolution should be not less than for NTSC; color rendition should be superior to NTSC; artifacts of the system should be less objectionable than are NTSC artifacts; the aspect ratio should be 16:9; and the subjective sound quality should be comparable to compact disc performance.

F. Scope of Services and Features

This is one of the ten selection criteria listed for the selection process in SS-WP4. Since all the advanced TV proposals have substantial capacity for auxiliary data, and that data, if in digital form, could be interfaced to arbitrary information appliances, the opportunity exists for different levels of interoperability.

Scope of Services and Features: the range of services and features supportable by the control functions and channel capacity devoted to ancillary data in an advanced TV system.

The current target value for this attribute in SS-WP-4 is increased capability and flexibility in the ability to provide audio, captioning, data services, etc.

This range of capabilities will be dictated by the constraints on the interfaces to whatever channel capacity is provided.

Work of the SMPTE Header/Descriptor Task Force can be the foundation for building future potential services into the system chosen by the FCC for advanced television.

digital television systems, in which non-graceful degradation for all kinds of impairments may be typical.

d. **Self-identification**

Process by which a data stream contains within itself certain identifying information concerning the information represented by the data stream. The identifying information can be incorporated periodically or at random, or in some cases only once per transmission.

e. **Block of image data**

Identifiable block of data representing image information, not necessarily of fixed length.

Examples: single high resolution still image; single frame of HDTV; group of frames in HDTV; fixed size block of compressed image data, without regard to image boundaries; variable size block of compressed HDTV images corresponding to a frame or group of frames.

f. **Identifier (immutability and registry)** For the long-term usefulness of identifiers, they need to be unique, long-lasting, and accessible. sseveral plans are possible for organizing unique identifiers, mostly using a tree and branch organization. To be accessible, a widely available registry that will endure needs to be established, and there are precedents for such registries within the international communications organizations.

g. **Universality**

The unique identification of encoding schemes and other information needed so that signals can be shared across systems and applications with minimal degradation or confusion.

h. **Source coding**

For HDTV, the processing by which the source image sequence is processed, compressed, and transformed into a representation suitable for a particular image application, independent of the means that may be used for transport. In adaptive source coding, there may be feedback from the channel to the coding algorithm.

i. **Channel coding**

The processing by which the representation of image sequences produced by source coding is prepared for transmission over a particular transport medium, modulated, demodulated and converted at the receiver into transport-independent image data. The method of creating a transmitted signal that is robust enough to be sent over a particular channel and received with sufficiently few errors that the original signal can be acceptably recreated. The use of error detecting and correcting codes, and the appropriate choice of modulation line code (voltage levels, pulse shapes, frequency templates, etc.) are used to implement channel coding on a given medium or transmission system.

appending, replacing, inserting, cropping, and overlaying. These capabilities can be supported by appropriate use of headers and descriptors.

t. **First-class data type**

u. **Parsing ability**

Ability to determine, in real time (i.e., without time penalties), what subordinate image structures or objects may exist within a main image or image sequence.

IV. Conclusions

This draft document provides a framework for collecting definitions of terms useful for discussing "interoperability" among various manifestations of video and image data.

Comments, additions, suggestions and improvements are invited.

Bob Keeler

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Interoperability Example

- Adaptation and compression of film
  - — Conversion of film to HDTV format facilitated by progressive scan, high quality motion information
  - — Compression of film converted to HDTV facilitated by
    - — proper detection of film mode
    - — simple adaptation of HDTV coder for film mode

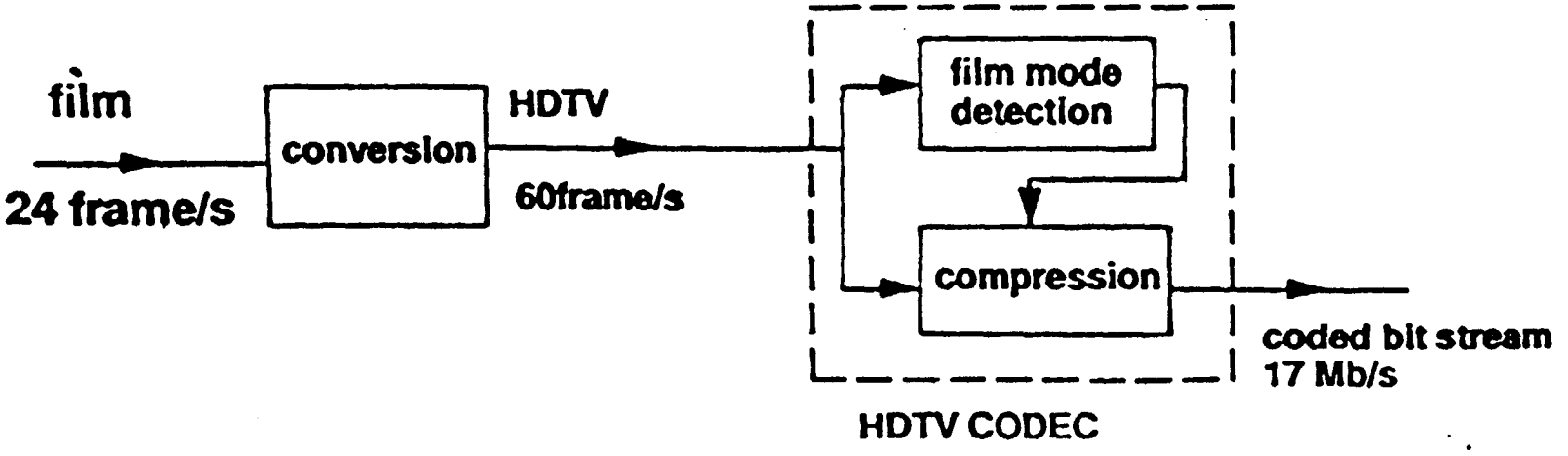
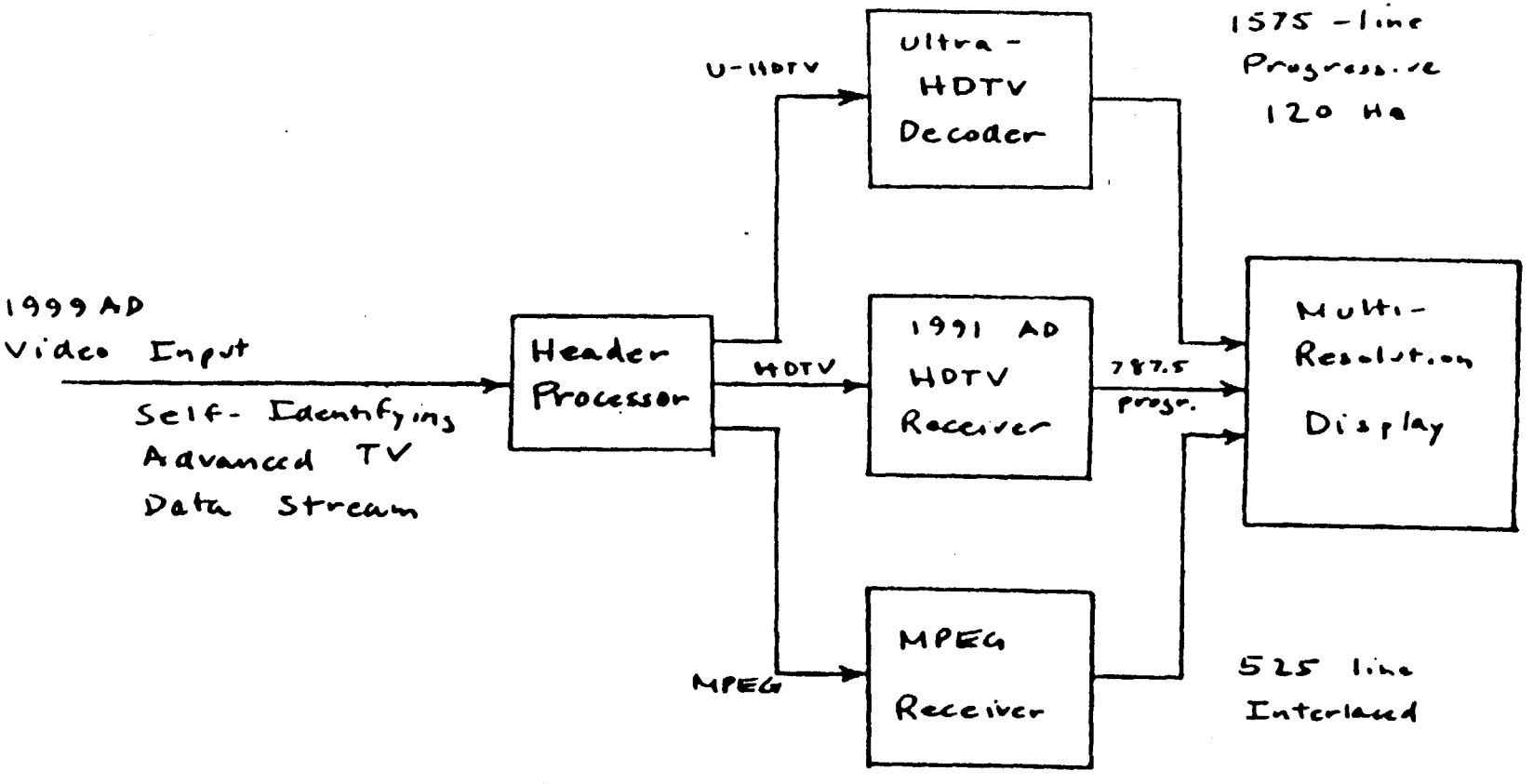


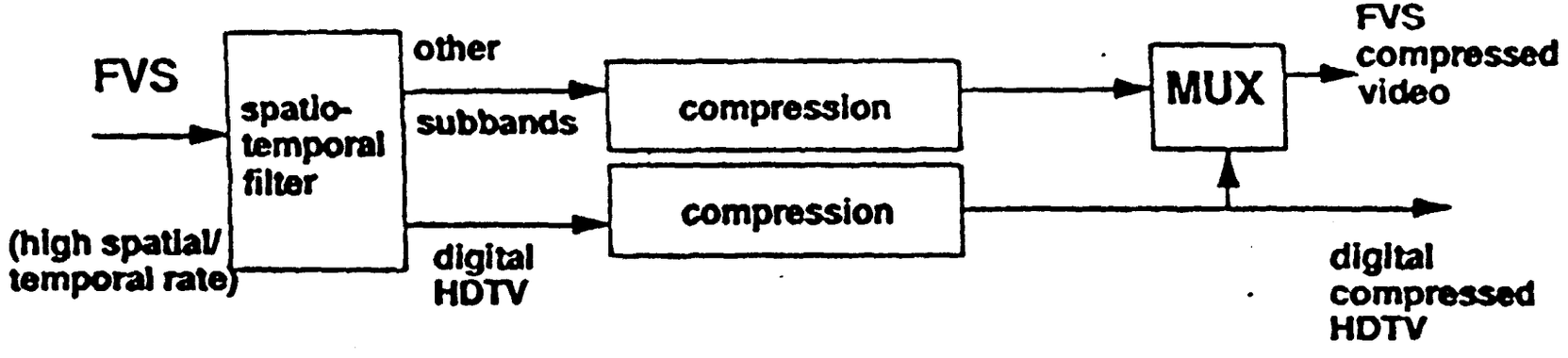
FIG. 3



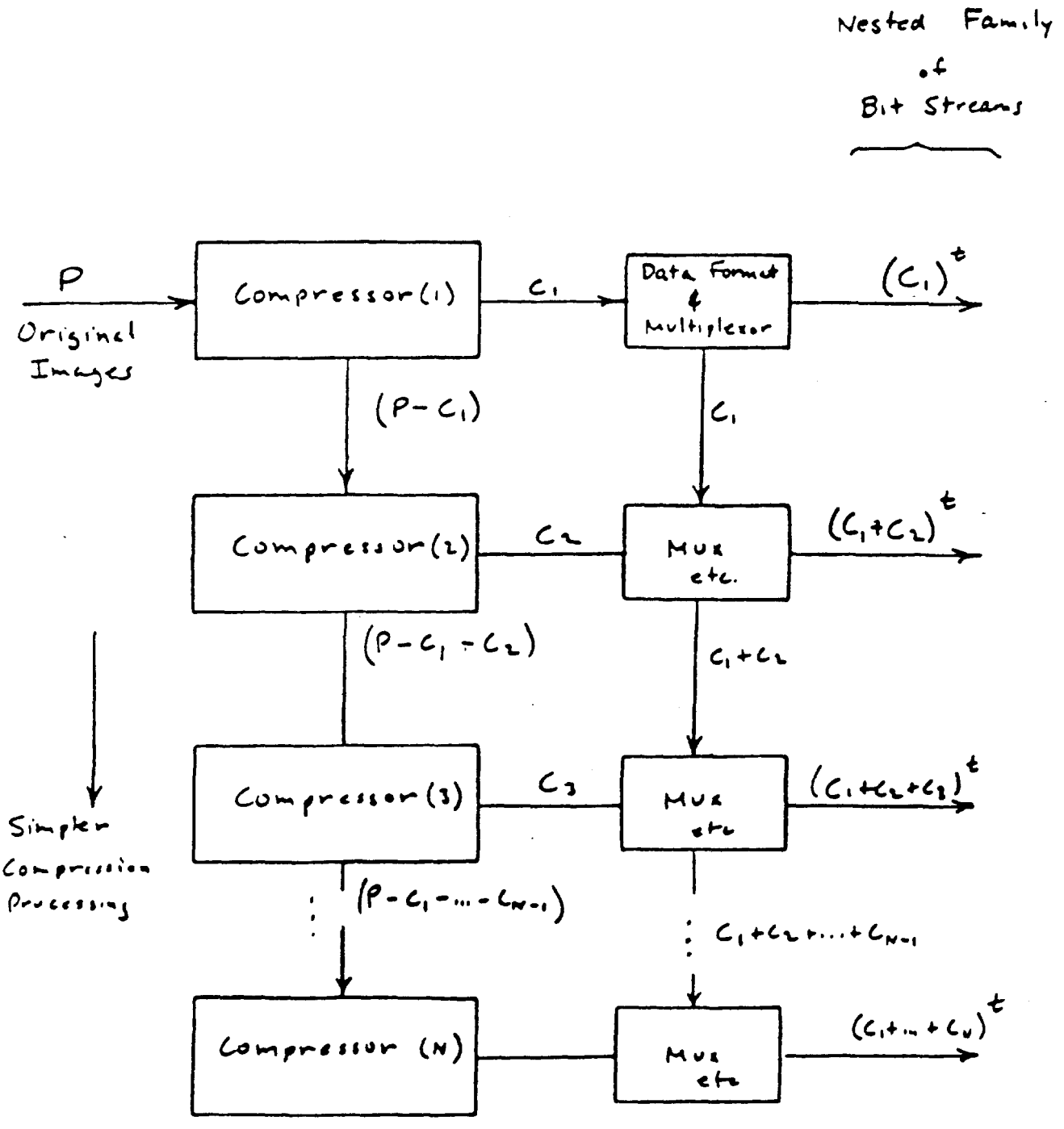
Example of Extensibility

Extensibility Example

- Extension to a future video system with higher spatial resolution and frame rate.



Progressive scan/square pixels allow simple spatio-temporal filter to decompose FVS signal into HDTV and the remaining

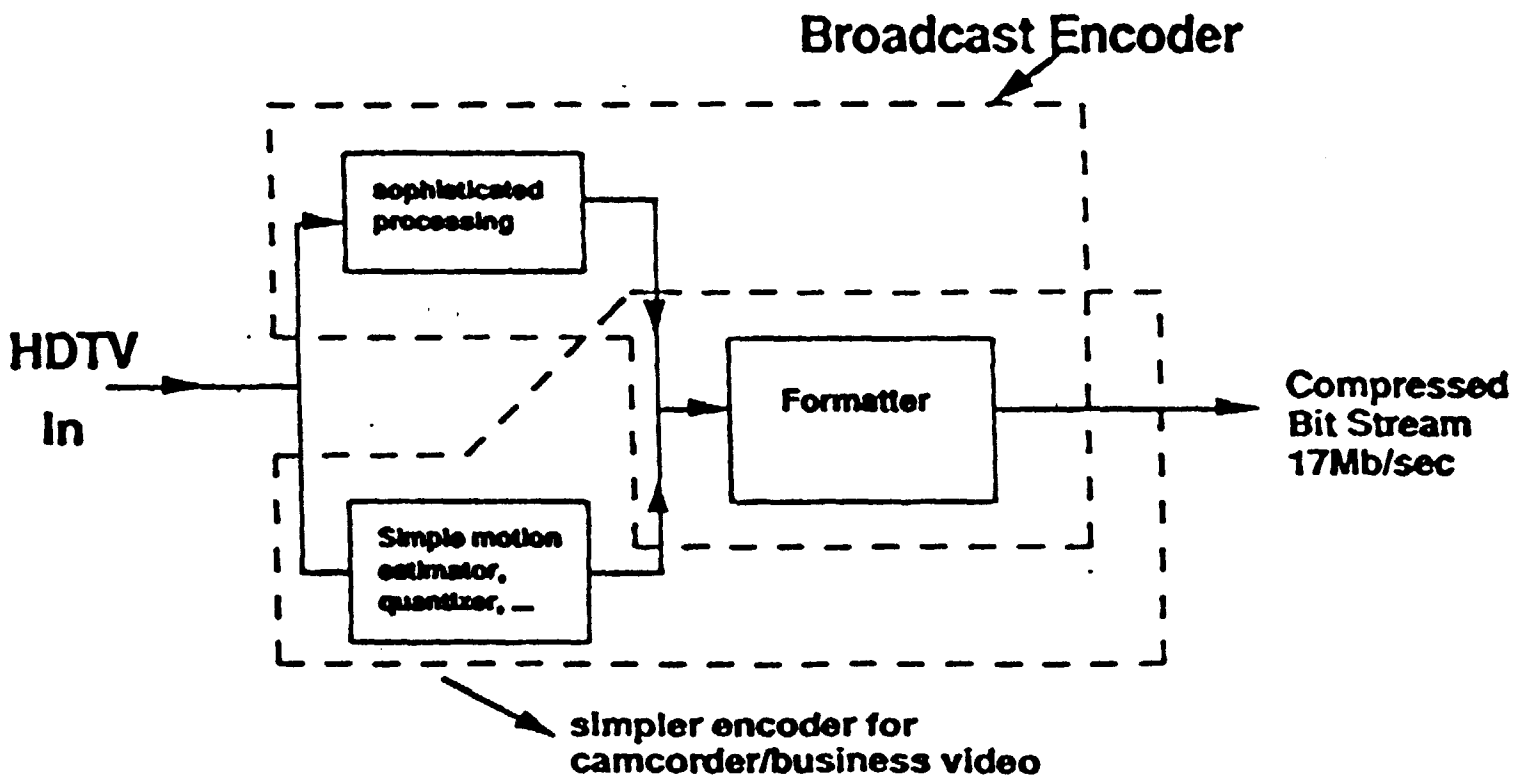


Example of Layered Coding

Fig. 7

Scalability Example

- For broadcast applications, encoder more complex to give good picture quality but it is modular ⇨ can handle applications requiring low encoder cost



- Simply related scanning parameters (to NTSC, PAL) make down coversion easy

Fig. 9

Attachment B: Reference Models / Architecture.